recently reprinted *A History of Entomology*, which deals only with American entomology, there is nothing else currently in print which deals at all extensively with its subject matter. The price being reasonable, many individual entomologists, as well as libraries, should find it a worthwhile buy.

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Botanical Symbiosis

Ectomycorrhizae. Their Ecology and Physiology. G. C. MARKS and T. T. KOZLOWSKI, Eds. Academic Press, New York, 1973. xvi, 444 pp., illus. $28.50. Physiological Ecology.

This book is a collection of papers concerned with the ecology of mycorrhizae. The authors interpret "ecology" very broadly, as is useful in view of the fact that the morphology, chemical composition, physiology, genetics, geographical distribution, and classification of mycorrhizae are not well enough known to provide an adequate foundation for the study of their ecology. Structure and morphogenesis are discussed by Marks and Foster, classification by Zak, distribution in forests by F. H. Meyer, growth of ectomycorrhizal fungi around seeds and roots by Bowen and Theodorou, mineral nutrition by Bowen, carbohydrate physiology by Hacskaylo, hormonal relationships in mycorrhizal development by Slankis, the rhizosphere of mycorrhizae by Rambelli, mycorrhizae and feeder root diseases by Marx, and applications in forestry by Mikola. The authors are currently publishing on mycorrhizae so their work has already been critically considered. They take some pains to review the literature, and in this they are aided by the publication within the last decade of at least nine symposia or texts on mycorrhizae.

A real difficulty in many studies of mycorrhizae is lack of identification of the fungi involved. Although this book contains author and subject indexes, it lacks an index to species. Successful application in forestry practice, such as the Austrian planting of *Pinus cembra* in timberline situations for avalanche control, has been much aided by Moser's careful mycological work.

The individual papers are careful, thoughtful presentations. Meyer's covers the widest intellectual range. Bowen brings in many ideas from the field of plant nutrition and attempts to make his discussion rigorous. Classification, as noted above, is simply unsatisfactory, a situation that certainly is no fault of Zak's. Slankis extends and defends the very interesting pioneering work he began long ago. The other papers illustrate nicely the extreme complexity of the subject and the many ways in which it cuts across conventional lines between plant-oriented disciplines. Could this latter account for the small representation of university researchers among the contributors?

Considerable emphasis is on forestry aspects of mycorrhizal problems, and this is no fault. Possibilities of application keep research and conclusions reasonable and testable. The heavy emphasis on a few tree species is disadvantageous, however, if mycorrhizal investigators allow themselves to be confined by their experimental material as plant physiologists have done with a very limited repertoire of crop plants. Mycorrhizae are of wide occurrence in natural vegetation, and noneconomic plants may be excellent experimental material. The investigators represented here are well aware of the importance of competition between plants, so their physiology is not automatically inapplicable, and they fulfill their aim of elucidating the ecology of mycorrhizae.

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Subunit Associations

Protein-Protein Interactions. Proceedings of a colloquium, Mosbach, Germany, Apr. 1972. R. JAENICKE and E. HELMREICH, Eds. Springer-Verlag, New York, 1972. viii, 464 pp., illus. $24.80.

This volume is the proceedings of a meeting that attempted to present an overview of molecular interactions in protein molecules. Out of this broad area of research, the colloquium concentrated on the functional advantages of multisubunit structures, with the emphasis on the nature of quaternary structure. The self-assembly and symmetry of these biological "supramolecular assemblies" are presented as a natural prerequisite for the development of diverse cooperative effects that are utilized in oligomeric proteins. These interactions often endow oligomers with increased stability or functional capability, improved efficiency, and the possibility for the control mechanisms essential for complex biological systems. Understanding the way such cooperative effects are mediated through intra- and intermolecular subunit contacts is of central importance in biology.

The symposium consisted of 20 invited papers which illustrate the diversity of solutions that nature has evolved to meet her needs in the hierarchy of molecular organization. The importance of quaternary structure in proteins is represented by the relatively simple tetrameric hemoglobin molecule, which remains a standard in the understanding of biological function on chemical and physical principles. The emphasis here and throughout is on the nature of the subunit associations and the resultant cooperative effects. Aspartate transcarbamylase, which consists of 12 polypeptide chains, is presented as one example of organization of a regulatory enzyme that uses separate catalytic and regulatory chains. Multienzyme complexes are one example of heterologous protein interactions. Besides profiting from quaternary structure in all ways accessible to monofunctional oligomers, multienzyme complexes have an additional inherent advantage of spatial organization for promoting efficiency of catalysis. Tryptophan synthetase is a small multienzyme complex which may be regarded as a dimer, $\alpha_2\beta_2$, of functional $\alpha\beta$ dimers. Although the individual subunits α and β_2 have distinct catalytic functions, the formation of the $\alpha_2\beta_2$ complex leads to large increases in the catalytic efficiencies of the partial reactions. Evidence is presented to indicate the formation of a composite active site where the preexisting sites in the α and β_2 subunits are brought into direct contact. Other topics include the protein assemblies in muscle, antigen-antibody interactions, the self-assembly of viruses, and the relevance of cell-cell interactions. In addition, there are papers on the nature of molecular forces involved in protein-protein interactions and on the importance of self-assembly and symmetry, and repeated examples of how experimental techniques of electron microscopy, x-ray diffraction, chemical and spectral probes, and others have been combined to elucidate the properties of complex biological systems to make a colloquium of this sort possible.

The book presents a broad yet cohesive summary of the recent developments in this area. The numerous high-quality figures and the inclusion of discussions enhance its value. Most of the

papers are written in reasonably general terms with good introductory comments so that the need for knowledge of previously published material is minimized. This is somewhat unusual in accounts of symposia and should make this volume of value to those outside the immediate field. One paper, on the multienzyme systems of fatty acid biosynthesis, is given in German.

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Glutamine Biochemistry

The Enzymes of Glutamine Metabolism. Based on a symposium, New York, Aug. 1972. STANLEY PRUSINER and EARL R. STADTMAN, Eds. Academic Press, New York, 1973. xx, 616 pp., illus. $16.

The metabolism of glutamine is of importance in the nitrogen economy of virtually all living systems. The formation of glutamine from ammonia and glutamate is an essential process for the assimilation and transport of ammonia. The amide nitrogen is utilized for the formation of a variety of other biological compounds, and both the amide and amino nitrogens are utilized for the biosynthesis of other amino acids. Glutamine, of course, is also an amino acid constituent of proteins and in some cases the glutaminyl residue serves a functional role in protein cross-linking reactions, for example in the formation of fibrin clots.

This book provides a fairly complete survey of what is known about these different glutamine-dependent reactions. A significant number of papers contain information that was unpublished at the time of the symposium that was the basis for the book. The book is logically divided into two sections, the first dealing with reactions involved in the interconversion of glutamate and glutamine and the second with the dozen or so enzymes, the amidotransferases, that catalyze the biosynthetic reactions in which glutamine serves as a donor of an amide group.

A comprehensive and comparative summary of the structures and of the catalytic and regulatory properties of the enzymes glutamine synthetase, glutaminase, and glutamine transaminase from bacterial and mammalian sources is provided by several review papers in the first section. Considerable attention is also given to the discovery in 1970 of the enzyme glutamate synthetase. Work on the properties of this enzyme and evidence that has established the "glutamine pathway" as the major route of ammonia assimilation in bacteria are reviewed. A unifying theme for this section is provided by several excellent contributions that emphasize work related to establishing the role of these different enzymes in the regulation of glutamine formation in vivo.

One common function of at least many of the amidotransferases would appear to be their ability to act as a "glutaminase," thus providing ammonia that subsequently reacts with an appropriate acceptor. Consistent with this view are the findings that several amidotransferases contain specific "glutamine binding" subunits that are capable of carrying out this function. It is apparent, however, from the detailed summaries of these enzymes presented in the second section of this book that this is certainly not true of all amidotransferases and that, in fact, there is a wide divergence in the structural, catalytic, and regulatory properties of these enzymes and in the complexity of the reactions catalyzed. Nevertheless, as Hartman points out, continued comparison of the similarities of the amidotransferases will continue to facilitate our understanding of these as well as other enzyme-catalyzed reactions. The comprehensive reviews of all the amidotransferases that are presented here under one cover will significantly aid investigators in this task.

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Atmospheric Physics

Radiation Processes in the Atmosphere. Second IMO Lecture. K. YA. KONDRATYEV. World Meteorological Organization, Geneva, Switzerland, 1972. xxxiv, 214 pp., illus. $20.50. WMO No. 309.

The present inadequacies in our understanding of physical processes occurring in the atmosphere and their formulation in numerical models are major obstacles to accurate prediction of weather and climate. In this book K. Ya. Kondratyev of Leningrad University has set himself the aim of "examining the problems of radiation factors in the general circulation of the atmosphere with a view to attracting attention to the most important unsolved questions." In successive chapters he comprehensively reviews measurements of the solar constant, albedos and emissivities of underlying surfaces, the radiation climatology of the earth, and aerosols and their radiative effects. These chapters are strongly oriented to measurements and detailed calculation, although surprisingly little stress is laid on establishing the accuracy of the calculations. The fifth chapter, dealing with radiative effects on the statics and dynamics of the atmosphere, hits the central theme. It is one of the most extensive discussions of this subject, and describes a number of interesting phenomena although the emphasis is necessarily on theoretical treatments and model results. These show that a dynamical problem in a radiating atmosphere requires a joint formulation and coupled solutions. The author's wide interests are evident by his extensive contributions in each of these areas.

The major problems he sees are worth reiterating. We need a highly accurate determination of the amount of solar energy impinging on the top of the atmosphere and the ability to monitor changes over a period of years and decades. This can now be done most straightforwardly from orbiting platforms. We need to understand the role of radiation during and after cloud formation, and its interaction with aerosols. These are now being studied observationally by the author's CAENEX program in the U.S.S.R. and some smaller projects in the United States. Perhaps most important, Kondratyev calls for increased understanding of the ways in which the atmosphere and the models that mimic it respond to radiative effects.

This is the crucial point. The studies cited, as well as more recent ones (publication of the original manuscript took almost two years), show that radiative effects must be included. However, we have very few heuristic concepts with which to assess the effects of radiative errors on the general circulation, although simple models developed by Stone and others may provide insights. Washington has reported that, for medium-range forecasts, considerable errors in radiative heating may be masked by errors in initial wind and temperature data. Taken together, these results suggest that the present crude treatments of radiative effects may suffice for one- to three-week forecasts. This is reinforced when one realizes that the useful accuracy of specifying radiative heating is probably limited by